Federal Communications Commission

Office of Engineering and Technology

Laboratory Division

RF Exposure Considerations for Wireless Charging Applications

Introduction

The choice of applying RF power to recharge batteries in consumer wireless devices has been explored by manufacturers as an alternative to conventional AC power-line adapters. While different designs and implementations are possible for various wireless charging applications, inductive coupling techniques are often used to transfer energy from a charger to specific client devices. The method requires various size inductive coils operating at different frequencies and power levels to achieve specific coverage requirements. The coils may be embedded in furniture, decorative objects and walls or ceilings to provide wireless charging coverage. When radiating antennas are used for the energy transfer, the implementation can often be limited by interference concerns. Thus, the RF exposure potential to users and bystanders is expected to vary according to factors inherent to the design of individual charging systems, which generally require different evaluation considerations to show compliance.

Part 15 and Part 18 Requirements

Depending on the operating configurations, wireless charging devices may be approved under Part 15 or Part 18 of the FCC rules. For some designs, both Part 15 and Part 18 requirements must be satisfied when RF transmission is used for charging (non-communication) and control (data). The applicable rules and radio services must be satisfied for equipment approval according to the individual implementation. Because of significant variations in design and operating characteristics, the procedures required to evaluate RF exposure compliance for wireless chargers are considered according to the exposure potentials of individual implementations.

Certain consumer devices operating under Part 18 are permitted to generate and use the RF energy locally. This applies to consumer products such as microwave ovens and ultrasound cleaners. The Commission has generally anticipated that the RF power is contained within a very close proximity or in an enclosure. Therefore, some of these products may operate with substantially high RF power and RF exposure concerns are generally quite small and limited to very low level leakage fields. Because of low exposure potential, these Part 18 devices have been categorically excluded from routine RF exposure evaluation to show compliance. There are also certain higher power induction heating systems used in industrial settings under Part 18; however, these are generally governed by occupational exposure requirements and according to other government and occupational health and safety regulations; for example, OSHA. Although categorically excluded from routine RF exposure evaluation, Part 18 devices are not exempted from RF exposure compliance. When

exposure concerns arise; for example, due to evolving products and operations, RF exposure evaluation may be requested under the provisions of §1.1307 (c) and (d) to determine compliance.

Operating Characteristics of Wireless Charging Systems

The RF output power of wireless charging devices can vary substantially according to design and implementation requirements. Proportionally higher RF power is typically required to operate these devices at lower frequencies; for example, 100 kHz LF vs. 900 MHz UHF. In addition, different energy coupling or radiating elements are used to provide acceptable operating efficiency for the intended charging applications and design implementations. The differences in operating configurations among individual applications are expected to have varying RF exposure concerns. Besides charging typical consumer devices, such as cell phones and laptop computers, the similar wireless techniques may be applied to charge medical devices and implants with different operating and RF exposure characteristics.

The introduction of wireless charging applications for consumer devices under Part 15 and Part 18 has raised concerns about potential for RF exposure that require additional considerations for certain implementations to address RF exposure compliance. For designs that are self-contained and the RF energy is highly localized within the charging system, with little or no exposure to users and bystanders, compliance may be assured without the need for evaluation. However, if the energy must be radiated across a short distance to reach the targeted client devices, or when the system is in idle, where users and bystanders may be exposed to the fields, it is necessary to examine the design and operational details to assess RF exposure concerns and to determine if evaluation or analysis may be needed to show compliance.

RF Exposure Requirements

The potential for exposure should be examined according to the operating configurations of the wireless charging system and the exposure conditions of users and bystanders. The RF energy absorption characteristics of body tissues are functions of the tissue dielectric properties and device operating frequencies. Tissues are less efficient in absorbing RF energy at lower frequencies. However, lower frequency often requires proportionally higher RF operating power to overcome RF design constraints; therefore, the reduction in energy absorption and increase in power must be both taken into consideration. The RF exposure requirements must be determined in conjunction with the device operating characteristics, according to the mobile and portable exposure requirements in Section 2.1091 and Section 2.1093 of the rules.

Based on the design and implementation of the wireless charging application, it must be clearly identified if mobile or portable RF exposure conditions apply. Devices that use coils or radiating elements only on walls or ceilings and are installed to provide at least 20 cm from users and bystanders may qualify for mobile exposure conditions. When portable exposure conditions apply, compliance must be determined with respect to SAR requirements. Existing SAR systems and test procedures are

generally intended for measurements above 100 MHz. SAR measurements below 30 MHz are problematic and difficult because dielectric parameters of the tissue-equivalent simulating media required for SAR measurements are undefined. It is also unclear if the typical range of tissue dielectric parameters can be easily formulated with tissue-equivalent materials at low frequencies. While numerical modeling can be an alternative, the constraints of substantial computational resources at low frequencies could introduce further limitations. Under these circumstances, the Commission has recommend a combination of analytical analysis, field strength, radiated and conducted power measurements, in conjunction with some limited numerical modeling to assess compliance.

When the operating frequency is above 100 MHz, existing SAR and MPE measurement procedures may be adapted to evaluate wireless charging devices for compliance with respect to mobile or portable exposure conditions. The grantee or its test lab should contact the FCC Laboratory with sufficient system operating configuration details to determine if RF exposure evaluation is necessary and, if required, how to apply specific test procedures. Below 100 MHz, especially when SAR limit applies and the device is operating at close proximity to persons, information on device design, implementation, operating configurations, exposure conditions of users and bystanders are needed to determine the evaluation and testing requirements. In addition, the influence of nearby objects may also need consideration according to the wireless charging system implementation; for example, the effects of placing the device, its coils or radiating elements on or near metallic surfaces.

Considerations for Inductive Charging Techniques

The potential for exposure from devices that use inductive charging loops may vary according to the coil coupling efficiencies of both the charging and receiving loops in the charger and client devices. When energy is tightly coupled between the transmitting and receiving coils with sufficiently small leakage fields in the surrounding, the coils may operate at relatively high power levels with minimal impact to exposure potentials. This may be the case for devices operating in the high kHz to low MHz range where magnetic coupling materials and other proprietary designs have been used to improve energy transfer efficiency and minimize leakage fields. The radiated emissions and RF exposure concerns can be expected to remain low even at moderate power levels for such implementations. However, information on the design, implementation and operating characteristics are necessary, in the form of an analysis report, to properly document that RF exposure evaluation is unnecessary. Tight coupling between the transmitter and receiver may result in apparent discrepancies between the radiated and conducted output power measurements, which should be clearly explained with respect to the coupling efficiency of the implementation and conservation of energy for the charging system to support the analysis.

Client Device Considerations

For charging systems that allow multiple client devices to be charged simultaneously, the range of energy transfer efficiencies and fields in the surrounding due to different loading conditions must be clearly identified for the different operating conditions introduced by multiple and/or different client devices. The influences of these varying operating conditions to RF exposure must also be addressed according to the types of client devices specified for the charging system.

Client devices such as cell phones and laptop computers require the appropriate receiving hardware to charge batteries according to the specific wireless charging implementation. The additional hardware may modify the RF exposure characteristics of client devices and introduce changes to the original emission, HAC compatibility and SAR characteristics evaluated without the charging hardware. If a client device may be used while it is being charged, additional exposure concerns due to influences of transmitters operating simultaneously may also need to be addressed. It may be necessary to document if such evaluation has taken place and if there is any change in the documented characteristics of such devices. These are dependent on the design and exposure characteristics of individual client devices, which may require additional evaluation or analysis for the client devices during equipment certification. For wireless chargers that operate with multiple and/or different client devices, the range of exposure variations associated with different client devices must be identified to assess the exposure potential of a charging system to users and bystanders.

Equipment Approval Considerations

Because of the anticipated design, implementation and operating variations in wireless charging applications and certain expected difficulties in evaluating RF exposure compliance, the conditions and situations described above should be considered to determine the types of information necessary for inclusion in inquires to the FCC Laboratory seeking RF exposure guidance on individual wireless charging devices. The exposure potential and evaluation requirements are determined according to the information provided in each inquiry. When it is determined that RF exposure evaluation is not necessary to show compliance, equipment approval may be processed according to normal procedures by a TCB, if certification is required; or a recognized laboratory, if Declaration of Conformity is appropriate. In some cases, an exposure analysis report may be reviewed and accepted through a KDB inquiry to enable authorization of the equipment. When evaluation is required to show compliance; for example, using field strength, power density, SAR measurements or computational modeling etc., the specific authorization requirements will be determined based on the complexity of the RF exposure evaluation.